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The psychometric properties of the CFSS-DS for schoolchildren in Saudi Arabia: a confirmatory factor analytic approach

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Author contributions and conflict of interest

Author contributions: A.A. and R.F. conceived the idea; A.A collected the data; A.A, GH, RF analysed the data; A.A led the writing and A.A, GH, RF contributed to the writing of the paper.

There was no conflict of interest for any of the authors of this study.

SUMMARY

Aim: to test the psychometric properties of an Arabic version of the Child Fear Survey Schedule-Dental Subscale (CFSS-DS) a using confirmatory factor analysis.

Methods: 2 convenience samples were obtained: Sample [1]: 600 boys (33%) and girls attending 4 public schools in Onizah and Sample [2] 800 girls attending 8 public schools in Buridah. The questionnaire asked the participant's age, gender and completion of the CFSS-DS. The data were subjected to exploratory factor analysis (EFA), parallel factor analysis, Cronbach alpha, confirmatory factor analysis (CFA) and goodness of fit statistics.

Results: 513 children in Sample [1] and 503 children in Sample [2] participated giving a valid response rate of 86% and 67% respectively. From the EFA 3 factors were identified and confirmed statistically using parallel factor analysis. The internal consistency of the 3-factors, dental fear subscale (0.86); hospital fear subscale (0.77) and stranger fear subscale (0.71) was good. The CFA showed that the current EFA model was an equivalent fit to the El Housseiny et al¹ model, however, the solution using El Housseiny et al's structure was distorted.

Conclusions: A 3-factor structure with acceptable reliability exists for this Arabic version of the CFSS-DS, confirmed by a CFA using an additional data set.

INTRODUCTION

Child dental anxiety is said to be a growing problem² with one in ten children experiencing such an intensity of dental anxiety that it affects their acceptance of dental treatment³. Child dental anxiety has been thought of as a specific type of anxiety³ with the observations showing that young children have fears, which are not so much to do with dentistry but are associated with other and additional factors, such as 'parent-child relationship, family cohesion, and the security of the child's attachments within the family' ⁴. Therefore, child dental anxiety is a complex matter⁵, and the need to identify children with high dental fear is important for all those involved in caring and treating children.

Many psychological numeric and picture scales exist which have been used for this purpose. These include the Modified Child Dental Anxiety Scale in its numeric⁶ and faces response formats⁷, the Child Fear Survey Schedule-Dental Subscale⁸ as well as picture scales⁹. More recent scales, such as, the 17-item Children's Experiences of Dental Anxiety Measure¹⁰ as well as others^{7,9,11} have undergone rigorous psychometric testing to ensure their reliability. This is of particular importance for those psychological questionnaires, which have been translated from the original language into different language versions, since translated versions may lose nuances within the items leading to inconsistency in response and consequently reduced reliability¹². A good example of such a scale is the CFSS-DS. The CFSS-DS has been translated into many languages¹³⁻¹⁷, including an Arabic version^{1,18}. Few of these language versions, however, have undergone rigorous psychometric testing. Using exploratory factor analytic procedures El-Housseiny et al¹, found their Arabic version to be a reliable and valid measure of child dental anxiety for Arabic-speaking children. However, unlike the Finnish language version, which used

more advanced statistical procedures to assess the CFSS-DS factor structure¹¹, El-Housseiny et al¹ did not do so. There has been doubt cast upon the frequently used 'rule' to determine the number of underlying factors extracted from a scale, e.g. the Kaiser unity eigenvalue rule¹⁹. A statistical approach using parallel procedures has, thus, been advocated for researchers designing new or when using existing measures and investigating their psychometric properties¹⁹. Therefore, the number of factors was not determined statistically, nor was a confirmatory factor analysis conducted to demonstrate the goodness of fit of El-Housseiny et al's proposed model from their preliminary EFA¹. It would seem reasonable to suggest that, to establish the measurement credentials of the Arabic version of the CFSS-DS, that El-Housseiny et al's¹ original study should be repeated with another two samples of Arabic speaking children. This would allow the CFSS-DS's factor structure to be re-examined, to determine the number of factors statistically in one sample, and then with a second sample, using confirmatory factor analysis test the goodness of fit of a new factor analytic structure in comparison with that from El-Housseiny et al¹.

Therefore the aim is to test the psychometric properties of the Arabic version of the CFSS-DS. The specific objectives being to conduct an EFA and determine the number of factors statistically; report on internal consistency and conduct a CFA using a separate sample of the EFA solution and compare this measurement model to that of El-Housseiny et al¹ and test the goodness of fit of the two models.

MATERIALS AND METHODS

Samples and locations

Sample 1: Onizah sample

Boys and girls from 4 public schools - 2 primary schools and 2 intermediate schools - in Onizah a medium-size town, with a population of 152,895, in Qassim Province, Saudi Arabia. This convenience sample consisted of 200 boys and 400 girls, aged from 8 to 15-years-old.

Sample 2: Buridah sample

Girls attending 8 public schools, 4 primary schools and 4 intermediate schools, Buridah the capital of Qassim Province, Saudi Arabia, with a population of 467,410. This convenience sample consisted of 800 girls, aged from 8 to 15-years-old.

Questionnaire and questionnaire administration

The questionnaire consisted of two parts: the first included questions about the participants' age and gender and the second part assessed child dental anxiety using the Arabic version of the CFSS-DS^{1,18}. CFSS-DS consists of 15 questions related to various aspects of dental treatment as, for example, fear of the dentist, dental treatment such as the local anaesthesia and so forth. The responses to the 15 items are on a 5-point-scale ranging from 1 (not afraid), 2 (a slightly afraid), 3 (fairly afraid), 4 (quite afraid) to 5 (very afraid), giving a total score when summed that ranges from 15 to 75. CFSS-DS scores of 38 or over are indicative of extreme dental anxiety.

In the girls' schools, the teacher responsible for child health distributed participant information sheets (PIS), consents and questionnaires distribution. For the boys, the questionnaire, PIS and

consent forms were distributed by the School Principal. The questionnaires were completed at home. The questionnaires were collected 3 to 4 weeks after distribution and between 2015 and 2017.

Ethical considerations

Ethical approval was obtained from Ethics Committee in Qassim University in Saudi Arabia, Ministry of Education in Saudi Arabia (Ethical Approval Code: EA/68/2014). Written Parental Consent was collected for participation in the study and verbal approval from the children prior to the questionnaire administration.

Statistical analysis

The data from the questionnaire was entered into the statistical software package SPSS version-22. Descriptive statistics were performed on the Onizah (Sample 1) and Buridah (Sample 2) data sets. EFA (using the principal components option) together with Cronbach alpha was conducted on the Onizah (Sample 1) data only. The data sets from Onizah and Buridah were converted into Excel prior to being imported into STATA15²⁰. The Sample 1 data from Onizah was subjected to a parallel factor analysis; the 'fapara' procedure in STATA. The Sample 2 data from Buridah was subjected to a Confirmatory Factor Analysis procedure using maximum likelihood estimation in STATA15. The fit statistics, Confirmatory Fit Index (CFI) and Root Mean Square Error of Approximation (RMSEA) were calculated.

RESULTS

Samples

Sample 1:

One hundred and twenty-three (24%) boys and 390 (76%) girls participated in the study. The total sample was 513, giving a valid response rate of 86% . The mean age of the total sample was 12.02 (95%CI: 11.86, 12.19) years, with an age range between 8 and 15 years. The mean age for the girls was 12.18 (95%CI: 11.98, 12.39) years: the boys had a mean age of 11.52 (95%CI: 11.31, 11.73) years

Sample 2:

The total sample (girls only) was 539, giving a response rate of 67%. After missing data sets were removed the final sample size was 507 giving a valid response rate of 63%. The mean age of the total sample of girls was 10.50 (95%CI: 10.27, 10.73) years, with an age range between 8 and 15 years.

Sample 1: Exploratory factor analysis

All of the scores for the 15 items from the CFSS-DS were subjected to an exploratory factor analysis (EFA) with Varimax rotation. Three factors were identified using the recognised system that is preferred to determine statistically the number of factors known as parallel factor analysis (fapara procedure in STATA). Parallel factor analysis determined the true number of factors or scales by using the same data set (Onizah: n=513). The Onizah data set was randomly jumbled and this procedure (the random jumbling of the data) was repeated 10 times. A principal components analysis was then conducted on this random data set and the loadings averaged to obtain the final solution. This solution, based upon 'random noise', was then

compared with the original data set as shown in Figure 1. The dotted line in the scree plot shows that 3 definitive factors emerged from the data ($n=513$). All of the eigenvalues for the raw data set (solid line) above the dotted line of the randomly generated data set demonstrates the identification of these 3 definitive factors. Factors 4 and 5 effectively overlap the dotted line and so are not considered to be distinct factors. The steep slope of the 'dip' in eigenvalue from Factor 3 to Factor 4 is also a good supporting piece of evidence to demonstrate that the CFSS-DS comprises 3 factors only. Subscale 1 was composed of fear of the dentist, injection, opening mouth, the dentist drilling, the sight of the dentist drilling, the noise of the dentist drilling, somebody putting instruments in your mouth and choking and had an eigenvalue of 5.96. It explained 39.76% of the variance. Subscale 2 was composed of fear of the doctor, of someone examining your mouth, having to go to hospital, people in white coats and having your teeth cleaned and had an eigenvalue of 1.38. It explained 9.19% of the variance. Subscale 3 was composed of being afraid of having a stranger touch you and of someone looking at you. This had an eigenvalue of 1.35 and explained 9.04% of the variance (Table 1).

Each of the subscales seemed to explain different aspects of treatment fear and therefore, Subscale 1 was named 'Dental Fear Subscale'; Subscale 2 was named 'Hospital Fear Subscale' and Subscale 3 was named 'Stranger Fear Subscale'. The internal consistency and reliability of the three scales was found to be high with the Dental Fear Subscale having a Cronbach α of 0.86; the Hospital Fear Subscale having a Cronbach α of 0.77 and the Stranger Fear Subscale having a Cronbach α of 0.71.

Sample 2: Confirmatory Factor Analysis

To determine if the factor structure in the EFA reported above could be replicated in a further sample of children from Saudi Arabia, a procedure known as confirmatory factor analysis (CFA) was performed. This statistical procedure has the merit of being able to declare a measurement model structure that can be formally fitted to a sample of data. The analysis enables the investigator to specify a model and test if it is a reasonable reflection of the pattern of relationships within the data set collected. In addition, indices (known as modification indices) can be requested to show where various parameter specifications within the model could be inserted to assist with the overall fit of the model. In other words, where there might be a 'strain' in the specified model indicated and where some constraints may be relaxed to improve the fit. The 'sem' (structural equation modelling) procedure in STATA15 was employed. Initial analyses were run to test the fit and also allow some constraints in the model to be relieved to improve the model's fit with the raw data.

[i] CFA fitted to Sample 1 EFA factor structure using Sample 2 data

The first CFA procedure of three factors as specified in the previous Sample 1 EFA was performed using Sample 2 data, and gave fit statistics as shown in the summary table of CFI and RMSEA indices. The CFI is regarded as a good fit if it achieves an index value close to 0.95 and the RMSEA is less than 0.06²¹. Inspection of the initial solution showed that the indices were not favourable and changes were sought to improve model fit. The modification indices alerted the researchers to allow 6 residual errors from pairs of items to correlate. The incremental improvements can be viewed in Table 2 to produce an overall fit that approximated to the raw data as indicated by the CFI = 0.933 and RMSEA = 0.071. The standardised model coefficients are detailed in the left pane of Figure 2. The factor loadings are all above 0.4 and the large majority above 0.6. This

showed a close correspondence of the items loading on the respective factors as defined in the original Sample 1 EFA.

[iii] CFA fitted to previously reported EFA factor structure published by El-Housseiny et al¹

An identical procedure was applied to Sample 2 with a crucial difference. The factor structure that was imposed on the Sample 2 data, this time, was the EFA solution previously published by El-Housseiny et al¹. Although similar in structure there were some important differences that can be found on inspection of the right pane in Figure 2. The CFI and RMSEA indices are reproduced in Table 2. The results of the fit indices are not dissimilar. There needed to be a set of correlated errors to be corrected to improve fit. However there were two substantial differences worthy of comment when viewing the path diagram. First the loadings on items in CFA [ii] were drastically lower on items 6 and 7 (0.22 and 0.23 respectively). Second the correlations between Factor 3 and the other two Factors (1 and 2) were calculated by the programme to be above 1.0. The researcher therefore reset these to be 0.99 for presentation purposes. In other words the solution became distorted in order to arrive at an explanation. The sem procedure using maximum likelihood estimation in STATA15²⁰ presented a solution even though, strictly speaking, it contained these two values that were beyond permitted statistical boundaries (i.e. correlations greater than one). An interpretation is that the addition of the item 'd1' to the other two items 'd6' and 'd7' into Factor 3 appeared to be a rogue assignment of items.

A further feature of the sem CFA analysis procedure is the benefit of being able to specify calculations using 'robust' errors. This additional facility brings advantages. The assumptions of statistical normality of the raw variables are not required and ease interpretation. The results of

these additional analyses using robust errors with the final models with the correlated errors showed virtually identical results and reassured the investigators that statistical distributions that did not correspond to normality had no influence on the final results.

DISCUSSION

The aim of this study was to examine the psychometric properties of an Arabic language version of the CFSS-DS by determining statistically the number of factors from a new exploratory factor analysis and testing the factor structure and goodness of fit by conducting a CFA using a second data set of the current factor structure and that found by El-Housseiny et al¹.

The initial EFA using the Onziah data (Sample 1) set revealed 3 factors, which were named, the Dental Fear Subscale; the Hospital Fear Subscale and the Stranger Fear Subscale. The internal consistency and reliability of the three scales was found to be high with the Dental Fear Subscale having a Cronbach α of 0.86; the Hospital Fear Subscale having a Cronbach α of 0.77 and the Stranger Fear Subscale having a Cronbach α of 0.71.

The EFA (sample 1) used the sophisticated parallel comparison between a 'dummy' sample consisting of random repetitions with the original data and showed convincingly that there were 3 significant factors as identified by the EFA. This is the first study to have employed the *fapara* technique to identify statistically the number of factors contained within the children's responses to the 15 items of the CFSS-DS. The *fapara* technique prevents misinterpretation and confusion arising when investigators are trying to decide upon the number of factors, using the 'rule of

thumb' of accepting factors which have obtained an eigenvalue that is equal or greater than one¹⁹. Such an approach may unwittingly result in misinterpretation due to overfactoring²².

On detailed inspection of the items that comprise each of the subscales it was observed that there were differences between the EFA solution from the current study and the structure reported in the previous study of El-Housseiny et al¹. To investigate this further CFAs were conducted modifying the model structure from either the current study or from the previous study. Interestingly, the original factor structure from El-Housseiny et al¹ did not fit well. The misfit (i.e. 'strain') was found to be located in the factor known as Factor 3¹. It should be noted that each solution required a number of correlated errors to be included to improve the goodness of fit. However, the previous reported structure by El-Housseiny et al¹ demonstrated some coefficients (estimated parameters), which were not logically possible (i.e. correlation coefficients greater than one).

The 3 factor reported solution from the work reported here (the current study), presents an understandable explanation concerning child dental anxiety. The reported 3 factor solution, is supported by other theoretical work, which has suggested that children may confuse what they experience at the doctor and or at the hospital with what they experience at the dentist⁴. Therefore the work presented here will be of interest to those working with dental anxious Arabic speaking children as it will allow them to assess the various dimensions of child dental anxiety, in relation to the child's fear of the dentist (the Dental Fear Subscale), hospitals (the Hospital Fear Subscale) and separation anxiety (Stranger Fear Subscale).

There are limitations to the work presented and this is in relation to the Buridah sample (Sample 2) being all girls, the questionnaire being completed at home and that the samples were collected 2 years apart. Although, much of the literature cites a difference in dental anxiety between genders, the same was not observed by El-Housseiny et al¹⁸, where they showed that the mean CFSS-DS score for boys was 23.50 (± 7.66) and for girls 23.51 (± 7.83). Since no difference in mean score in CFSS-DS existed for Saudi children, this suggested that the use of an all-girl sample for the CFA study was acceptable. With regard to the time between the data being collected, Rantavuori et al¹¹ proposed that there was a stability of the psychometric properties of the CFSS-DS over time, implying that 2 years between data collection would have little effect on the psychometric properties, as reported here.

Folayan and Kolawole²³, have commented on the cultural issues regarding the readability of CFSS-DS especially with very young children, whose parents may complete the questionnaire for them. To overcome this potential limitation children aged 5-7 years-old were omitted from the current study. It was assumed that children aged 8 years and above would be more autonomous. Therefore, despite the above limitations, this psychometric study, supports the use of the CFSS-DS, with children aged 8 years and over.

Therefore in conclusion, this study has examined the reliability of an Arabic language version of the CFSS-DS and shown that it has a 3 factor structure with acceptable reliability. A CFA showed that the current EFA model was a good fit using an additional data set. Thus the Arabic version of the CFSS_DS may be used with confidence to assess child dental anxiety.

Why this paper is important to paediatric dentists;

- Provides evidence that this Arabic language version of the CFSS-DS has good psychometric properties;
- It may be used with confidence to assess child dental anxiety in Arabic speaking children;
- This version of the CFSS-DS will provide an accurate assessment of child dental anxiety, assist in the identification and appropriate behavioural management of Arabic speaking dentally anxious children.

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Table 1 Current study: CFSS-DS exploratory factor analysis: subscales (means, 95%CI and reliabilities) and items (means, 95%CI and factor loadings)

	Cronbach's alpha	Factor loadings	Mean (95%CI)
Subscale 1 Dental fear factor	0.86		20.05 (19.38, 20.73)
(d1) How afraid of the dentists		0.57	2.00 (1.89, 2.11)
(d3) How afraid of the injection		0.43	2.56 (2.43, 2.68)
(d5) How afraid of opening your mouth		0.45	1.64 (1.56, 1.73)
(d8) How afraid of the dentist drilling		0.83	2.85 (2.73, 2.98)
(d9) How afraid of the sight of the dentist drilling		0.81	2.84 (2.36, 2.61)
(d10)How afraid of the noise of the dentist drilling		0.82	2.41 (2.28, 2.53)
(d11) How afraid of somebody putting instruments in your mouth		0.63	2.47 (2.35, 2.59)
(d12) How afraid of choking		0.56	3.64 (3.54, 3.77)
Subscale 2 Hospital fear factor	0.77		7.72 (7.41, 8.02)
(d2) How afraid of the doctors		0.72	1.57 (1.49, 1.65)
(d4)How afraid of someone examining your mouth		0.58	1.53 (1.45, 1.61)
(d13)How afraid of having to go to the hospital		0.74	1.60 (1.51, 1.69)
(d14)How afraid of people in white uniforms		0.69	1.23 (1.17, 1.29)
(d15) How afraid of having the dentist clean teeth		0.63	1.79 (1.69, 1.89)
Subscale 3 Stranger fear factor	0.71		5.19 (4.99, 5.41)
(d6) How afraid of having a stranger touch you		0.87	3.06 (2.93, 3.19)
(d7)How afraid of someone looking at you		0.79	2.14 (2.03, 2.25)

Table 2 Fit indices for CFA of the 3 factor solution of EFA current study and El-Housseiny et al (2016) using the Buridah data

	Fit indices for CFA of the 3 factor solution of EFA current study using the Buridah data set		Fit indices for CFA of the 3 factor solution of EFA of El-Housseiny et al ¹ using the Buridah data set	
3 factor model: correlated errors	CFI	RMSEA	CFI	RMSEA
correlated errors=0	0.847	0.103	0.828	0.109
correlated errors=1	0.870	0.095	0.881	0.091
correlated errors=2	0.893	0.087	0.896	0.085
correlated errors=3	0.907	0.081	0.909	0.080
correlated errors=4	0.916	0.078	0.924	0.074
correlated errors=5	0.925	0.074	0.930	0.071
correlated errors=6	0.933	0.071		

Figure 1 Scree plot: parallel factor analysis of the data to show 3 definitive factors

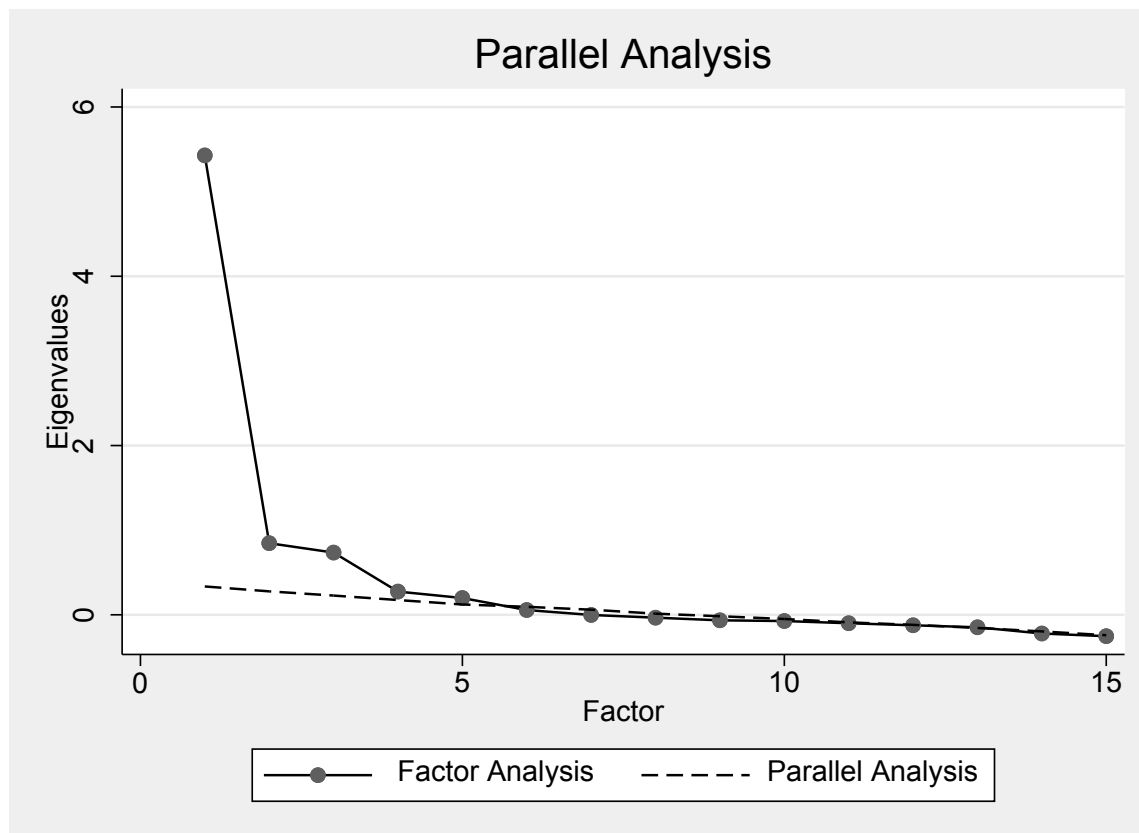
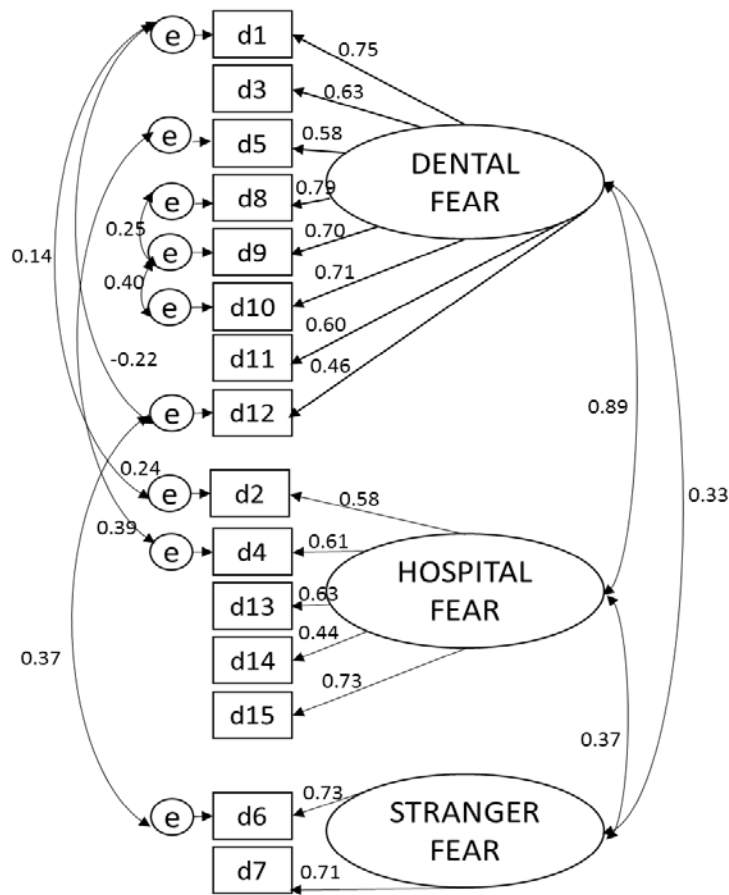
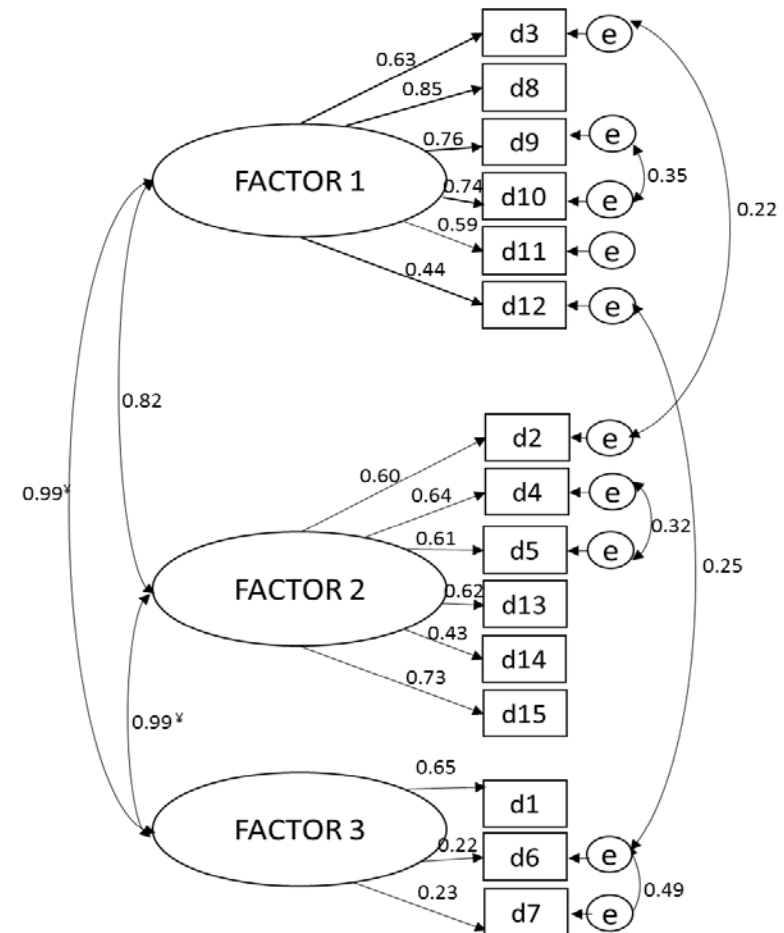


Figure 2 Path diagrams of CFA results showing latent variables, items, factor loadings and correlations (standardised solutions using robust maximum likelihood estimator)

Pane 1 (current study)



Pane 2 (El-Housseiny et al¹)



¥ Correlations reset to just below unity as initial solution gave inflated estimates